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Perspective

Calling energy inequalities into the transition agenda

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ABSTRACT

The presented perspective paper delivers insights into the complex problem of energy inequalities in the context of the Russian invasion of Ukraine. The war resulted in a loss of stability in Europe's energy system and increased social issues and difficulties in meeting energy transition targets. The perspective presented calls for a broader framework for analyzing energy inequalities. It delivers an attempt at such a framework through which three specific cases of energy transitions—Norway, Germany, and Poland—are investigated. These countries represent three energy regimes, different socioeconomic and energy systems, and face other challenges. Despite these differences, the outbreak of the war shows the need for a common policy agenda to avoid negative repercussions, such as social cohesion crises. Therefore, this paper argues that European solidarity, energy justice, and coherent policies are prerequisites if the goals of climate neutrality, energy stability, and a just energy system are to be achieved in each country and Europe.

1. Introduction

The invasion of Ukraine, described by some as a "fossil fuel (FF) war" [1], has ultimately shaken up the energy stability of most European countries and reshaped the landscape, making it even more complex.[1] While the focus has often been on climate change, putting pressure on the existing sociotechnical regime, we now face a trilemma: climate change, the aftermath of the pandemic, and the Russian war against Ukraine, which reinforce one another and cause dangers to just energy transition.

The objective of the presented perspective is to consider how the war in Ukraine affects energy inequalities and the process of energy transition in Europe. Initially, we evoke popular narratives about war as accelerators of regime change. They primarily take two forms: optimistic scenarios, where the break from Russian FFs will accelerate the energy transition toward new regimes of renewable energy sources (RES) and net zero emissions, and pessimistic scenarios, which focus on obstructions and reinforcement of the *status quo* [4–6]. Although crises may open "opportunity windows" for profound social change, we are far from an unambiguously and exclusively positive scenario.

We employ the theoretical approach of the multi-level perspective (MLP) to discuss the proposed issues, additionally bringing the issues of energy inequality into the framework, with a particular focus on the potential threats (adverse effects) that inequality may cause to transformative regime change. We use secondary data to provide a broader perspective of energy inequality in the context of regime destabilization. Furthermore, we examine three cases of European countries (Norway, Germany, and Poland) at different stages of the energy transition and FF dependency. On this basis, we discuss the policy implications of energy inequality and the prospects for its mitigation.

1.1. Methodology

In this perspective paper, we supported the analysis by publicly available secondary data for individual case studies (EU-SILC survey, McKinsey & Company report, Statistical Review of World Energy – BP, Statistics Norway). The MLP as a conceptual framework not only encompasses the issue of energy inequalities related to the war in Ukraine and energy transition but also includes the different starting points and different response potentials of the three selected countries (Norway, Germany, and Poland) considered in the context of contemporary challenges.

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[1] The Russian Federation has already successfully opposed the European Union's energy transition plans for many years [2], simultaneously realizing its own agenda of deepening divisions within and between European countries by making them dependent on Russian oil and gas [3].

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2. Toward new energy regimes

The energy-related debate is not only about resources and technological developments but also on the present and future of highly complex and unequal social systems [7]. One useful analytical framework for sociotechnical transitions is the MLP introduced by Geels [8–10].

The MLP understands transitions as nonlinear processes that result from interconnected developments at three levels: the sociotechnical landscape (which forms the external conditions for these developments), sociotechnical regimes (of established rules that reproduce and maintain existing systems), and niches (where innovations are incubated). Transitions are understood as a shift from one regime to another, and they happen through the mediated relations between the regime and the landscape and niche. Initially focused on niche developments and technology shifts, the MLP framework eventually opened up agency and bottom-up actions, social norms, and behavioral patterns. Nowadays, the MLP addresses the interaction of multiple regimes, the repercussions of regime reproduction and/or destabilization, and how landscape changes and regimes interact [11].

We propose including the problem of energy inequalities in the MLP framework (Fig. 1), as these issues have not been widely addressed thus far. For us, inequalities, including energy inequalities, are directly related to regimes of energy, production, and consumption. Great inequalities have become a core element of today's extractivist regimes [12–14], in which a predatory relationship with nature, the gross domestic product (GDP) obsession [15], and the ideology of "privatizing profits" and "socializing losses" [16] have been accompanied by unprecedented disparities, not only in income but also in access to and use of resources and energy.

Energy inequality analysis within the MLP framework has not been widely used thus far. The current understanding of energy inequality focuses on households and differences in energy consumption levels [17]. Households are indeed critical units of analysis in the energy transition process—one that is all the more challenging, as they must address the aftermath of current major crises and are not without internal tensions. On the one hand, the energy crisis hits households—particularly vulnerable ones—the hardest; on the other hand, households must have the ability to absorb niches and transform them into rules and practices that are universally applicable as part of the green sociotechnical regime to come. However, the just energy transition ought not only to lead through the reduction of energy poverty and increase in disposable income but also to address, among others, equitable access to critical resources, enabling the development and diffusion of green technologies and intergenerational equity.

Today, we witness that sustainability transitions meet resistance. This resistance is not just caused by the persistence of existing regime actors and the slow development of new niches. We argue that resistance is also caused by other phenomena: (1) the unequal distribution of material and immaterial resources that allow people to participate actively and form sustainability transitions in different parts of society, (2) an unequal distribution of the burdens of the sustainability transitions, and (3) an unequal distribution of the gains of these transitions. These phenomena need to be addressed sufficiently; otherwise, the sustainability transition will slow down and preserve existing unjust relations. Therefore, we claim that it is necessary to include the MLP processes that empower social groups to actively contribute their perspectives in the transition processes, such as energy citizenship or energy cooperatives, so that the gains of the transition are socialized [18]. It is also necessary that vulnerable groups stress their rights in the resistance toward extractivist practices, which put higher burdens on them and endanger nature and their quality of life.

Future regimes are contingent on a shift away from "extractivist" capitalism and should be achieved through a just transition based on equity and solidarity. We argue that if broad public support for a sustainable transition is at stake, the prospect of the future cannot be a narrative that reproduces existing inequalities. Just transition must be realized even against the resistance of numerous existing regimes' beneficiaries [11] and with support for those who are the most vulnerable.

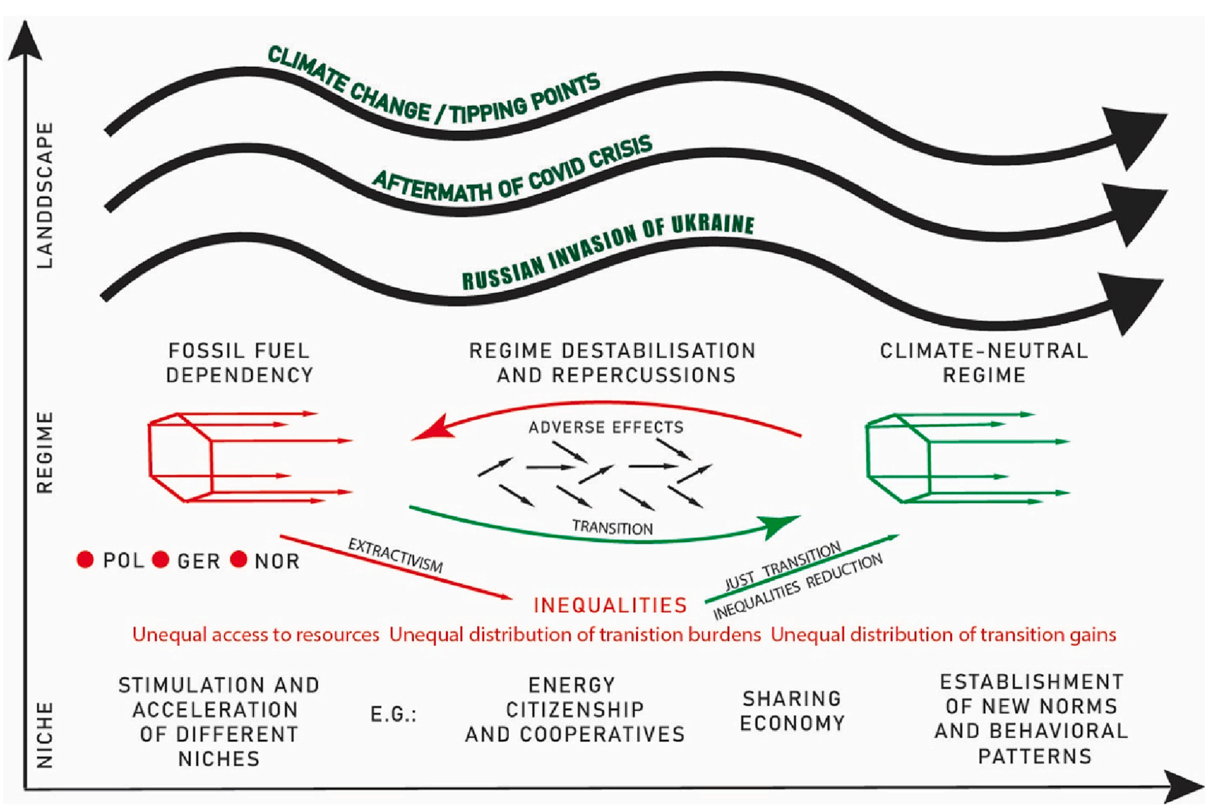

Fig. 1. Sustainability transition: Landscape, niche acceleration, regime destabilization, and inequalities.

As sustainability transitions are "purposive" and strictly related to "collective goods" [9], this process requires top-down directionality and political guidance [19].

3. Taking energy inequalities into account

Generally, there is a consensus that energy policies must be considerably redesigned. The International Energy Agency (IEA) recently stated that the "reorientation of trade flows has already taken place, with lower flows of oil from Russia" [20,34], and increased short-term demand in oil and coal will be substituted by clean energy in the long term. However, overly "positive" scenarios are characterized by one dimensionality. They, too, are often techno-optimistic, which does not seem to be entirely in line with existing data [21,22]. They also omit the issue of inequalities that are interconnected with welfare and well-being crises. For instance, neither the latest *World Energy Outlook 2022* [20] nor the *Global Impact of War in Ukraine: Energy Crisis* reports [23] pay attention to energy inequalities.

Although inequalities characterize all complex societies, the current situation is without historical precedent, and some researchers describe inequalities as extreme, fatal, and unacceptable [24,25]. Contemporary socioeconomic or environmental issues tend to be more acute in societies with greater inequalities [26,27]. Given the planetary boundaries, without decreasing the energy consumption of the wealthy, the living standards of the poorest cannot be lifted [28] in an environmentally harmless way. Moreover, inequalities foster crises in the social fabric, such as polarization and social unrest [29]. Inequalities are obstacles rather than drivers of green development [30], and the problem of energy-related inequalities is becoming increasingly important [31,32].

In this perspective paper, we rely on a definition of energy inequality by Bianco, Proskuryakova, and Starodubtseva [33,3], who recently proposed that "energy inequality refers to the disparities in energy use and can be measured within an individual country and/or region or between groups of countries/regions." For the purposes of our analysis, we decided to reshape and extend this definition to take into account components such as (i) the energy-related differences on which various regimes are based, such as the level of development and energy mix, access to critical resources, and others, (ii) inequalities between different social groups and individuals (wealthier people may find it easier to switch to clean technologies, while the lower middle and lower classes remain more dependent on FFs. It is also blind to ethnicity, race, and/or gender, to name a few other dimensions), (iii) intergenerational equity, such as the production of long-lived nuclear waste [34], and (iv) the complexity of sociometabolic energy-related processes in the context of energy use [35].

Not all of the above-mentioned reservations fit easily into the MLP framework. However, we propose to consider (1) the complex socioeconomic base with attention paid to welfare and well-being (e.g., current levels of development, the stage of the energy transition, disparities in living standards, structural transformations, cohesion, and social fabric crisis), (2) resource and technological conditions for the maintenance and development of green energy (e.g., unequal access to rare raw resources) that bind present with the future, and (3) domestic and supranational policy measures and agendas. All these dimensions are interdependent.

4. Cohesion at stake?

As the current challenges of landscape change and regime destabilization are complex, we tackle some of the repercussions of the energy crisis (i.e., facing the dangers of petrification or deepening existing inequalities). This, in turn, may result in severe social and political cohesion threats and, eventually, serious obstructions in the transition process (through reinforcement of business-as-usual logic, maintenance of FF-based technologies, reproduction of harmful habits, and others). In the following sections, we discuss three topics related to energy inequalities that may threaten cohesion and a just transition: welfare and well-being decline, access to critical resources, and policy challenges.

4.1. Welfare and well-being crises

Due to skyrocketing energy prices, we face a sharp decline in living standards, widening the gap between energy-poor and -affluent social groups [36]. Even if we focus only on European societies, energy inequalities are a significant factor threatening social welfare; they are already being reinforced because "with high gas prices and also for carbon emissions (which means coal is not a cheap option), there are large near-term costs" for entrepreneurs [37]. Thus, rising inflation, as the energy costs are passed on to the consumer [38], and economic slowdown, with the risk of stagflation, should not be ignored [39]. This applies particularly to the European Union (EU) countries closest to Ukraine and poorer Central and Eastern Europe (CEE) countries.

There is likely an increase in the number of households affected by energy poverty to be observed, most of which cannot afford to keep their homes adequately warm (Fig. 2). Although official figures for 2021 still put the number of EU citizens at 34 million [40], estimates are emerging that the figure is now more than double.

Comparing the three selected countries, it is clear that the inability to heat the home adequately is lowest in Norway, while it is significantly higher in Germany and Poland. The high indication rate in 2020 in Germany (7 %) resulted from a combination of factors, of which the coronavirus pandemic played a key role. The subjective assessment of the inability to keep the house adequately warm was due to the order to stay indoors, resulting in higher energy consumption and heating bills. In 2021, German household support policies (the *Corona-Hilfe* program) were introduced, and mobility restrictions were loosened. This is reflected in a drop in people declaring themselves unable to heat their homes to 3.2 %, which is still a high figure for Germany.

These disruptions may result in a social fabric crisis, which may manifest in at least three ways. The first leads, through the increase of relative and/or absolute poverty caused by high prices and unemployment, to the intensification of anger and social protests. Under some conditions, it may form a new political agenda and new sociopolitical forces but more often serves to channel negative emotions. This was, for instance, the nature of the "yellow vests" protests in France [41]. The second, also fueled by unmet needs and increasing economic deprivation, leads to nationalist sentiments and particularism [42]. The third way goes through overly individualistic coping strategies of crisis and civic privatism, which are equally parasitic to social cohesion.

4.2. Access to critical resources

The advancement of the energy transition partly depends on access to specific resources. The chances of future access to green technologies are also currently at stake, as we face a "hidden" and fiercely competitive race for access to raw materials and rare minerals [3]. The IEA stresses that "minerals are essential components in many of today's rapidly growing clean energy technologies—from wind turbines and electricity networks to EVs. Demand for these minerals will overgrow as clean energy transitions gather pace" [43]. Increasingly, attention is being paid to the disconnect between climate ambitions and the availability and acquisition of critical rare earth minerals, without which the transition will be impossible and/or very expensive. In addition, unsustainable extraction of these minerals may deprive future generations of the prospect of social welfare based on low-carbon technologies.

Fig. 3 shows the critical raw materials necessary for clean energy technologies, including nuclear power.

4.3. Policy challenges for cohesion

In recent years, the EU's common policy has not forged itself without

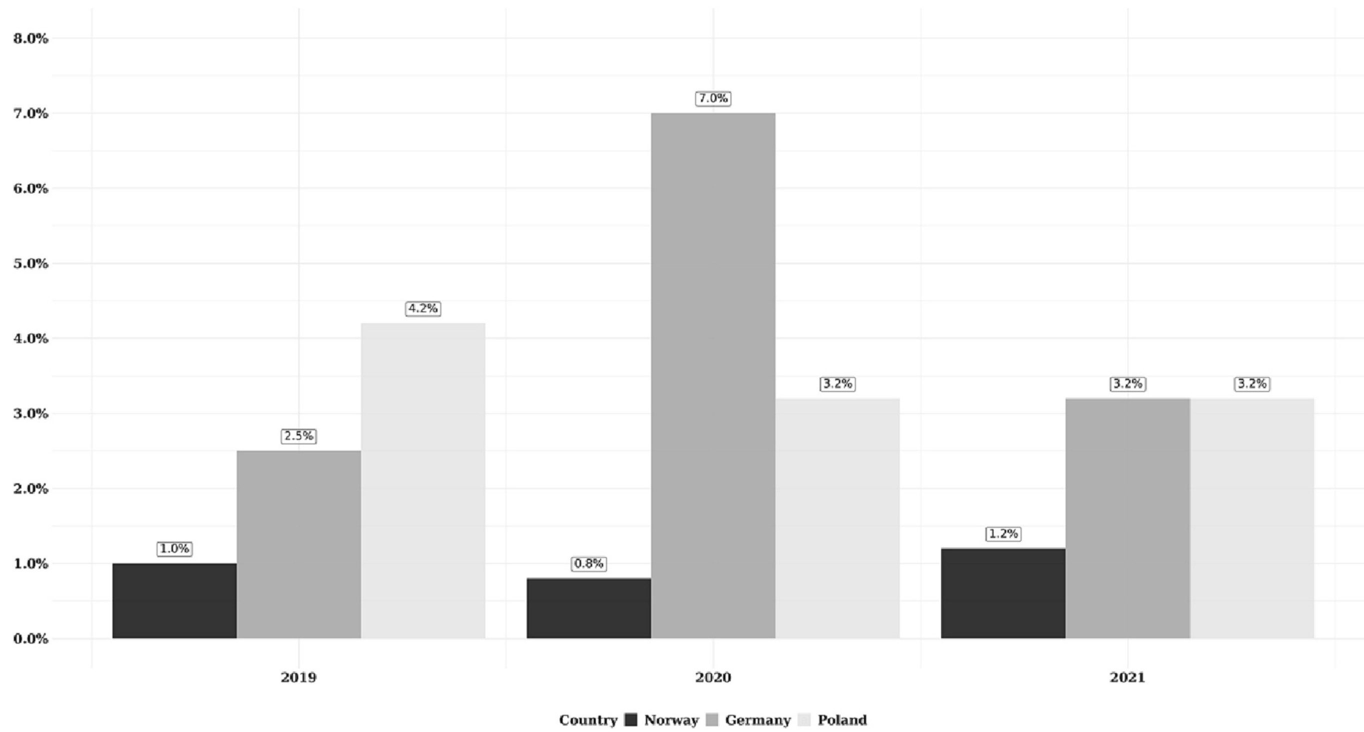

Fig. 2. Inability to keep home adequately warm.
Source: EU-SILC survey; note: 2021 data for Norway from Statistics Norway (SSB).

problems, often facing the challenge of increasing polarization. Critics of the imbalance of power in the EU have often pointed to the deepening of the East–West divide. Discussions around multi-speed Europe have fueled the populist right in countries such as Hungary and Poland. As pointed out by some commentators [44] and researchers [45], instability resulting from the energy crisis and rising inequalities might make some, mostly CEE countries, prone to populism and anti-EU sentiments. These issues must be addressed with anti-austerity yet green policies.

5. Many paths, one goal

In the following sections, we discuss three European countries: two EU member states (Germany and Poland) and one EU-associated country (Norway). These countries represent the “three worlds” of socioeconomic and energy development, as they differ profoundly in their energy mix (Table 1). Norway, a highly developed country based primarily on RES, became a significant FF exporter to the EU and a guarantor of frail energy stability immediately after the outbreak of the war. At the other extreme is Poland, an emerging economy based on coal, where energy transition plans represent a quasi-revolutionary challenge. Germany is one of the world's largest economies, dependent on cheap resources from Russia for an extended period; it was forced to reconcile economic growth with energy transition while consistently phasing out nuclear power.

5.1. Norway: advanced in green energy consumption and natural gas exporters to Europe

Norway's energy system has a very high share of its energy production and consumption covered by RES (Table 1), playing a dominant role in electricity generation. In contrast, natural gas is a source of national income; it is not widely used in Norway, but Norway is the largest exporter of natural gas in Europe and has recently provided even more supplies (Fig. 4). Today, 50 % of the natural gas that Germany imports comes from Norway.

5.1.1. Energy prices and inflation rate

Energy prices in Europe are linked to natural gas costs. Due to shortages after the invasion, the prices of natural gas increased. The crisis further deepened due to the sabotage of Nord Stream pipelines. As the Norwegian power system is integrated into the Nordic and European electricity markets, changes in electricity prices have hit Norway as well. This worsened in 2022 because the hydropower reservoirs in Norway were not filled up as usual. As a result of these processes, prices of electricity and other goods and services have increased, which has hit poorer households that have increasing problems with keeping their homes warm since many homes are heated by electricity (compare Fig. 2), while the producers of electricity can receive great profits. The inflation rate increased from 2 % to 5.9 % in December 2022.[2] The rate is much lower than in other European countries but not typical for Norway. Therefore, we also witness the phenomenon of the “working poor” in Norway—people who have a paid job but cannot afford to pay their bills for housing, energy, and food from this salary and are dependent on extra jobs, subsidies, and charities.

5.1.2. Access to critical resources

There is a need for increased access to mineral resources to carry out the sustainability transition. A proposed new mineral law is now in public consultation.[3] The challenge is to manage this within the framework set by consideration of the natural environment and local communities.

Norway has a rich tradition of copper and nickel manufacturing. Copper has been the most essential metal in Norwegian mining history. The Norwegian mining company Nussir plans to open a copper mine in Repparfjorden in Finmark, where Norway's largest deposits are located. The government granted an operating license in 2019. However, the

[2] SSB: Consumer Price Index. Update 10 January 2023. Consumer price index – Statistics Norway (ssb.no).

[3] Høring NOU 2022:8 Ny minerallov (2022) Høring – NOU 2022: 8 Ny minerallov – regjeringen.no.

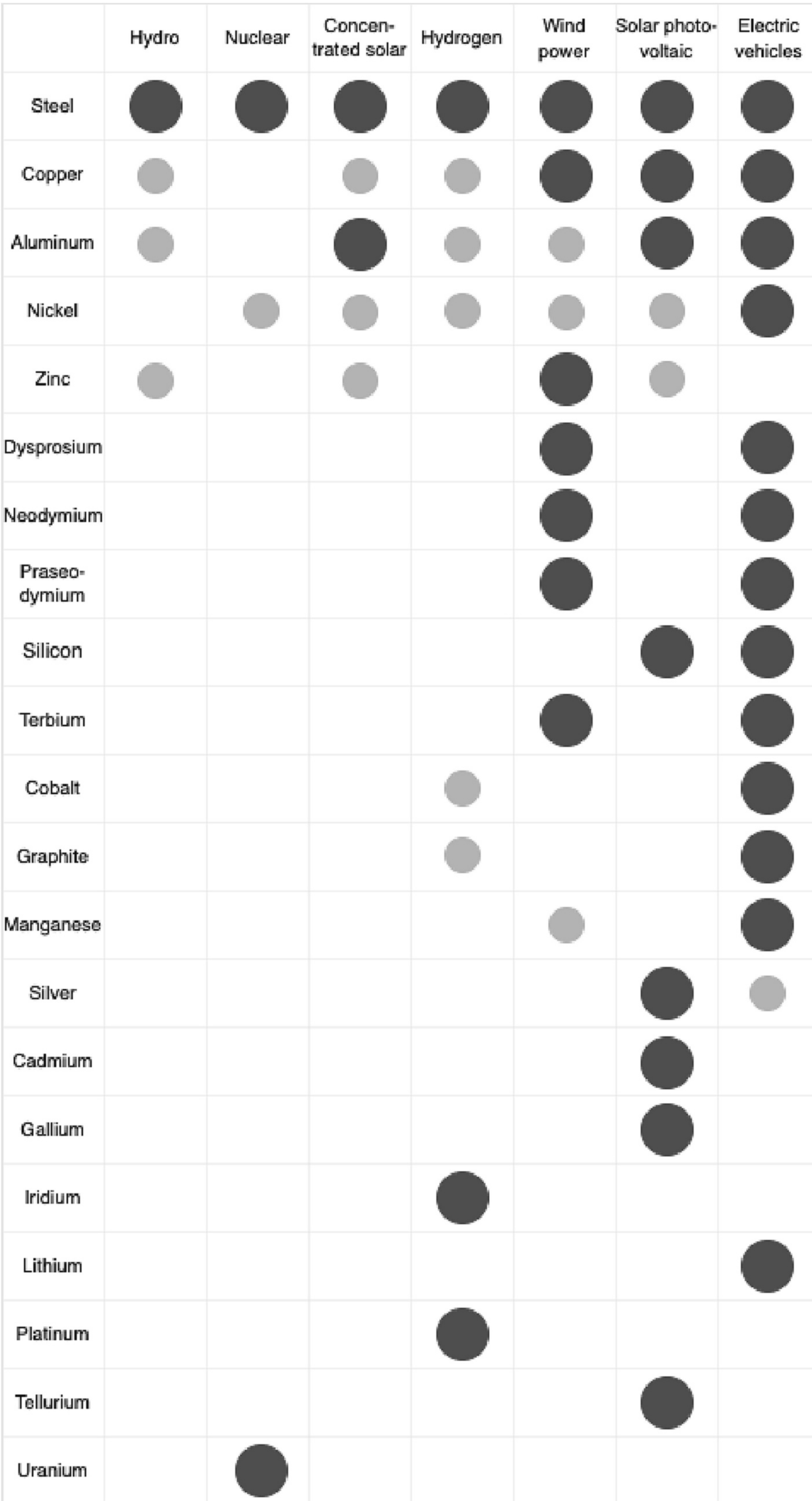

Fig. 3. Materials critical for the transition to a low-carbon economy by technology type.
Source: McKinsey & Company 2022[1].

[1]The raw-materials challenge: How the metals and mining sector will be at the core of enabling the energy transition. Retrieved from https://www.mckinsey.com/industries/metals-and-mining/our-insights/the-raw-materials-challenge-how-the-metals-and-mining-sector-will-be-at-the-core-of-enabling-the-energy-transition.

Table 1
Primary energy consumption by source (%), 2021.

	Coal	Oil	Gas	Nuclear	Hydro-power	Wind	Solar	Other renewables
Norway	1,62	18,65	7,61	0	66,51	5,47	0,09	0,04
Germany	17,46	34,53	26,9	5,15	1,49	9,15	3,81	1,51
Poland	43,41	31,78	19,3	0	0,51	3,52	0,86	0,63

Source: Statistical Review of World Energy—BP (2022).

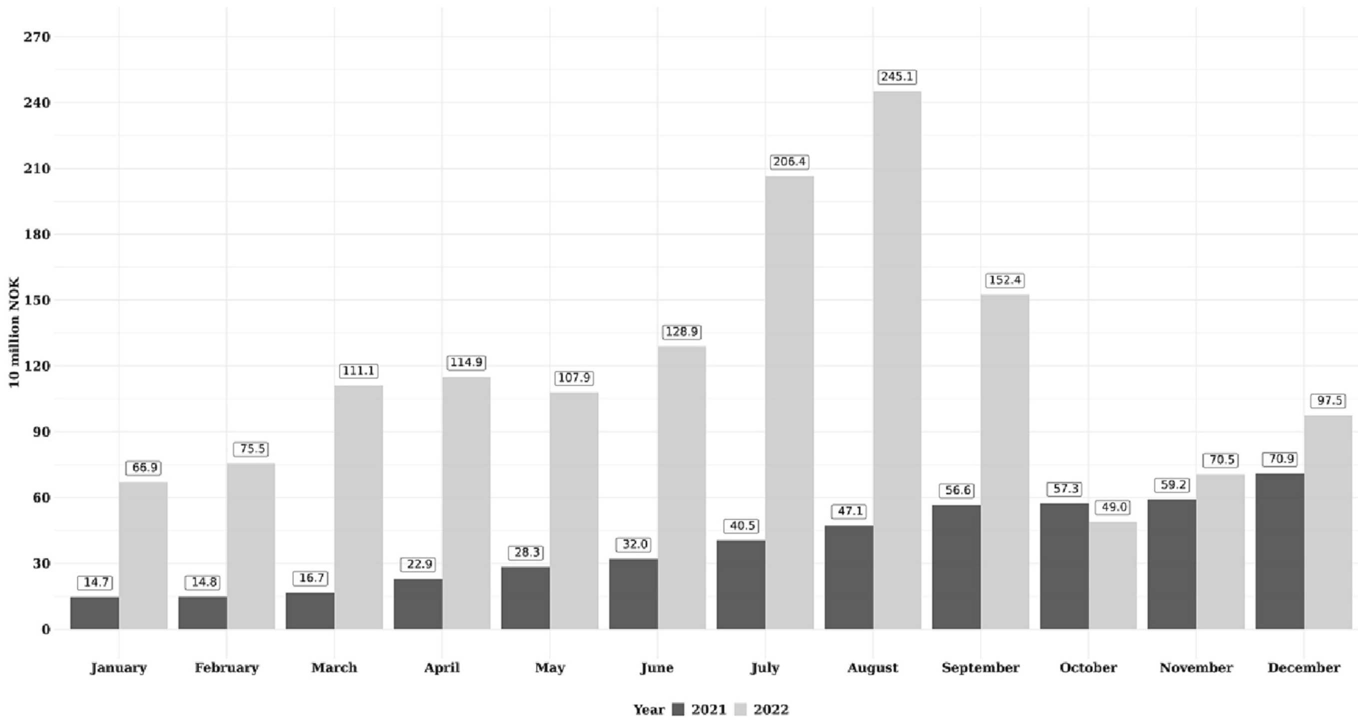

Fig. 4. Exports of natural gas by Norway in 1000 mill. NOK. Seasonally adjusted figures: Monthly data for 2021–2022.
Source: Statistics Norway (SSB).

local community disputed the decision due to probable environmental damage, which would also endanger the living conditions of local indigenous people. Norwegian Glencore Nikkelverk is the biggest nickel refinery in the Western world. However, there are no mining operations for nickel production in Norway. One future option could be in Sulitjelma, Nordland.

Due to the high share of electric vehicles (EVs) in Norway, which is one of the main avenues for reducing road transportation greenhouse gases (GHGs), the necessity for the sustainable recycling of batteries appears. Therefore, in 2022, Hydrovolt opened Norway's first pilot recycling plant for lithium-ion batteries. This will save resources and reduce the need for mining nickel and cobalt.

5.1.3. Policy options

Norwegian policy has three main goals, which are independent of which political party is steering the government: developing the welfare state, ensuring economic development, and addressing climate change by reducing GHG emissions.

The invasion of Ukraine did not undermine these goals but made them harder to achieve. The latest data from 2021 show that a meager share, about 1.2 % of the population, cannot afford to keep the home adequately warm. However, electricity prices, as electricity is the primary heating source in Norway, might dramatically increase this share. Therefore, the government introduced benefit schemes that cover 90 % of the energy price above an average level for a month of 70 øre per kWh and jointly measured household consumption in housing associations and condominiums. This will be extended until the end of 2023.[4]

Energy efficiency has been targeted by governmental policy over the last 15 years and is now defined as an improvement in energy intensity of 30 % from 2015 to 2030.[5] Energy consumption per dwelling has significantly decreased, from 2 toe per dwelling in 2000 to 1.71 toe in 2018, but further improvements are necessary. Therefore, the government improved funding for ENOVA, a public agency that provides subsidies for private households for energy-efficiency measures.[6]

Norway has a considerable share of electricity production based on hydropower; in 2021, there was an installed hydropower of 33,403 MW. Recently, policies aimed at new electricity production from small hydropower and onshore wind power have been introduced. The deployment of the latter has halted after resistance by local communities, especially in Northern Norway. A main avenue is offshore wind, which is still very costly because of the deep sea and stormy weather. In May 2022, the Norwegian government announced plans to allocate 30 GW of

[4] Regjeringens Strømtiltak: husholdninger (2022). Regjeringens strømtiltak – regjeringen.no.

[5] ODYSSEE-MURE (2021) Norway energy profile: energy efficiency trends and policies.

[6] Enova: Smart energy and climate measures (2022) Smarte energi- og klimatiltak | Enova | Enova.

offshore wind capacity by 2040 to double the current electricity production. Since 2018, the installation of solar photovoltaics (PVs) has increased in Norway, but it is still rather limited. However, with rising energy prices, the installation of solar PV roofs became popular in 2022.

5.2. Germany and 'Energiewende'

Germany's energy system is complex and diverse, with a mix that includes FF, nuclear energy, and RES. Germany is now undergoing the *Energiewende*, which means moving away from nuclear energy and FF toward RES [46]. However, these plans have recently been suppressed by the war and the cut-off of Russian gas [37]. Originally, gas was meant to play a stronger role in the energy transition as the cleanest type of FF energy. Coal is planned to be fully phased out by 2038. Electricity generation from RES has been systematically expanding, and stronger reductions in FF sources must be achieved in transport and heating.

Despite progress with RES, the German energy system still depends on FF to a large extent. Oil and gas contribute the largest share of the total primary energy supply and final consumption, and coal remains an important source of fuel for power generation. Germany is importing natural gas and liquefied natural gas from Norway and is also planning hydrogen imports.

5.2.1. Energy prices and inflation rate

Energy prices in Germany have fluctuated in the last few years—some types of energy have increased, while others have decreased. According to data from the Federal Statistics Office of Germany, the average price of electricity for households in Germany has increased slightly in recent years. However, since the second half of 2021, "household electricity prices, including taxes and levies, were highest in (...) Germany (EUR 32 per 100 kWh)," which demonstrates how much the low energy prices were related to—among others—preferential contracts with Russia.[7] Energy prices drive inflation, which reached 11.3 % in Germany.[8] In addition, in 2022, the prices of gas and oil, which are still frequently used for heating, increased strongly. Many low-income households cannot afford to pay heating bills. In 2022, a benefit for all households with gas, oil, and pellet heating systems was issued, and at the end of the year, price breaks for electricity, gas, and heating were introduced. Subsides are also available for changing heating systems to heat pumps, although the modernization speed is slowed down by the shortage of installation experts and long waiting times for the components. In addition, households with the lowest incomes have access to social security benefits that, to a considerable extent, reduce extreme poverty.

5.2.2. Access to critical resources

Rare minerals play a role in Germany's energy system in several ways. They are used to produce renewable technologies and energy-efficient appliances. Some of these minerals essential for Germany's energy sector include (a) lithium, used in producing lithium-ion batteries, which are commonly used in EVs and renewable energy storage systems, (b) cobalt, used in the production of lithium-ion batteries, as well as in the production of high-strength magnets for wind turbines, (c) neodymium, used in the production of high-strength magnets for wind turbines and EVs, (d) indium, used in the production of PV cells, LED lights, and other energy-efficient technologies; (e) rare earth elements, such as cerium and yttrium, which are used in producing wind turbines, EVs, and other renewable energy technologies (Fig. 2).

According to existing data, Germany has small lithium, cobalt, and neodymium deposits and some rare earth elements. However, these deposits are insufficient to meet the country's demand for these minerals, and Germany relies on imports to meet its needs.[9]

5.2.3. Policy options

Several goals guided Germany's energy policy, and despite the war, they remained unchanged. Most importantly, it is about reducing GHG emissions because Germany has committed to reductions in line with the Paris Agreement. This is in tandem with the next challenge (i.e., increasing the use of RES), as Germany has set ambitious targets for increasing its shares to achieve 65 % by 2030 and 80 % by 2050. An equally important objective is to enhance energy efficiency. Germany has already implemented many measures to improve efficiency and reduce energy consumption. Interestingly, even before the invasion of Ukraine, an important element of energy policy was ensuring energy security. Germany is working to diversify its energy mix to reduce its reliance on a single energy source, intending to reduce the risk of supply disruptions and increase energy security as an important element of energy policy. Most recently, bans on FF-based heating systems in newly constructed buildings, as well as the EU-wide ban for new cars with combustion engines, have been discussed.

5.3. Poland: coal-fired power over renewable energy

In Poland, the share of electricity produced from RES was 16.9 % (30.4 TWh) in 2021, which means more than 70 % of hard coal and lignite in the energy mix. The transformation of the Polish energy sector is progressing but much less dynamically than in, for instance, Germany. This is an effect not only of the historically determined development of the energy sector, with a century-long coal dependency and strong mining culture, but also, more recently, of the mining lobby slowing down the transition to RES. According to the Industrial Development Agency JSC, there were 78,900 employees in the mining sector in mid-2021. By comparison, according to the International Renewable Energy Agency, more than 116,800 people were already working in the Polish RES sector in 2020.

Wind power and PV have the largest share of renewables. As a result of the war, the configuration of countries from which Poland imports electricity has changed. Since the beginning of this year, Sweden has been the largest electricity supplier to Poland (via SwePol Link), followed by Lithuania and Germany.

5.3.1. Energy prices and inflation rate

As in virtually all of Europe, energy prices in Poland have risen significantly. Although the price of electricity began to rise in 2020 due to the increased demand for electricity during the pandemic and the high cost of CO_2 emissions, particularly in the Polish context, the war further reinforced this trend. Rising electricity prices are driving inflation, which reached a high of 17.4 % in November 2022 (*Statistics Poland* 2022). According to government benefit schemes, the Solidarity Shield,[10] electricity prices for residential consumers in 2023 will be frozen at the 2022 level.

5.3.2. Access to critical resources

To introduce low-carbon energy technologies in Poland, critical raw materials, such as boron, lithium, titanium, gallium, vanadium, and strontium, are indispensable [47]. These are essential raw materials for developing wind and solar technologies, Poland's main RES. In the Polish case, "the concentration of REE (rare earth elements) in minerals is rather low; their impact on the national economy is small. Potential

[7] https://ec.europa.eu/eurostat/cache/infographs/energy/bloc-3c.html?lang=en) – Electricity and energy prices in Germany - statistics & facts | Statista.

[8] Harmonized index of consumer prices (HICP) inflation rate of the European Union in November 2022, by country. Europe inflation rate by country 2022 | Statista.

[9] Sources: Federal Institute for Geosciences and Natural Resources. (2020). Mineral raw materials – Germany; Bundesverband der Deutschen Industrie. (2019).

[10] https://www.gov.pl/web/family/solidarity-shield–protection-for-families.

sources of these metals are secondary materials such as phosphogypsum, the uranium tailings, and the waste electrical and electronic equipment (WEEE)" [48]. In the context of these conditions, "dependence on Russian raw materials is even greater in Poland" [49].

5.3.3. Policy options

In the official narrative of the Ministry of Climate and Environment, Poland's three main energy policy aims are enabling a just transition, building a parallel zero-carbon energy system, and maintaining good air quality. However, the Polish government "intends to use the war in Ukraine to put the brakes on the entire climate policy, and especially the EU's 'Fit for 55 package', as, for example, former Prime Minister Beata Szydło has forthrightly announced" [49]. The main barriers to the development of RES include (a) limited opportunities for private entrepreneurs to finance green investments, (b) legal regulations and administrative procedures, and (c) outdated energy grid infrastructure. All these elements translate into the problems of the dynamic development of RES. Without extensive and diversified investments, transmission networks and energy storage cannot be developed. The same is true of legal and bureaucratic barriers that slow down or block investments in, for example, wind energy.

Energy transition prospects seem to be the least ambitious in Poland. The government's strategic document, *Energy Policy of Poland until 2040*,[11] focuses on RES, clean air, and a zero-carbon energy system. This means a significant reduction in energy derived from burning coal and the closure of all mines by 2049.

In Table 2, we summarize policy implications addressing the bundle of war-driven energy crisis and climate-neutrality transition.

6. Policy implications for a joint European agenda

Above all, there is a need to strengthen a common, environment-harmless, and solidarity-based energy policy for climate-neutral futures, including directional support for countries at lower stages of transition. Although these goals have not been questioned at the European level, the war landscape may produce serious obstacles. Potential threats to the above-mentioned policy might be particularism paths taken by national governments. Examples of such dangers may be either the monopolization of access to resources by wealthier and stronger states or the utilization of internal socio-economic tensions toward populist politics and backlash policies. In countries such as Poland, EU climate targets have already been used by populist right governments to whip up anti-EU sentiment.

In addition, according to the reformist transition framework [see [50]] accepted by the EU, alternative FF supply chains (e.g., gas) need to be established. They ought to exclude any cooperation with authoritarian political regimes. This is to prevent the abrupt collapse of European economies and societies and future energy dependency.

Rare earth minerals, raw material extraction, and supply chains must also be established in a way that excludes support for authoritarian powers. Access to these resources should be equitable to avoid the dangers of cut-throat competition and multi-speed development. Material recycling opportunities must be prioritized to ensure access to these resources and to prevent the export of electronic waste and pollution to developing countries. A just transition must consider intergenerational justice, environmental burdens, and the interests of vulnerable communities.

Effective anti-inflationary and fiscal policies that underpin green growth and redistributive systems that prevent radical falls in living standards and support vulnerable groups should be implemented and maintained despite the allure of austerity. Research and development policies should include not only technology but also put more stress on interconnections between technological and social innovations, focusing on labor markets and green job opportunities. Environmental education and the development of new social norms concerning the environment should be broadly supported. These tasks should be carried out in close cooperation with a wide range of stakeholders (e.g., civil society organizations and social movements).

7. Conclusions and recommendations for future research

Russia's invasion of Ukraine has profoundly changed the landscape and affected the energy transition. The key question is whether the energy transition will accelerate or slow down. We have argued that one of the significant and underdiscussed issues in analyses and policies that condition regime transitions is inequalities. Their reduction or increase, as a result of regime shifts, affects the transition process.

We have included the problem of energy inequalities as adverse effects in the MLP framework. We have pointed out that the present concept of energy inequalities, which focuses on "energy use," is too narrow. It does not allow for an understanding of the negative impacts of unequal access to and use of energy. We have therefore discussed the need for broadening the research perspective to include aspects related to the crisis of welfare and well-being, the currently crucial problems of access to the critical resources needed to implement the green transition, and the policy guidance. Although the perspective presented is partly defined by the need of the moment, it allows for further development of the energy inequality concept; thus, further theorizing is expected.

We used the proposed theoretical framework for the empirical analysis. The three countries selected were exemplifications of different starting points and strategies for dealing with the energy crisis in the face of environmental challenges. The differences between them point to the need for decisive policy guidance, sensitive to national conditions (e.g., the problem of decelerating decarbonization and/or increasing extraction of other FFs) and the challenges of international and intergenerational equity (e.g., rare earth minerals extraction) in the sustainable transition challenges.

The war in Ukraine has introduced a major re-evaluation of previous energy transition paths. On the one hand, the process of closing coal mines has been temporarily halted (Germany) and has given rise to a political campaign to delay the process in the context of a lack of access to Russian gas (Poland). On the other hand, the current situation has had the effect of increasing the extraction of natural gas (Norway), which now feeds economies previously based on contracts with Russian companies (e.g., Germany).

The sustainable energy transition takes different forms in the three selected European countries, for instance, from energy transition-fostering bans (as in the case of FF-based heating systems in newly constructed houses in Germany and Norway) to transition-decelerating subsidies (as in the case of the mining sector in Poland [see [51]]). These paradoxes and emerging particularisms intensify the need for policy guidance.

We are aware that our analysis has limitations. We had to leave out some related issues, such as the problem of increasing militarization. The increasing GDP share streamed for militarization not only changes the structure of public expenditure but, above all, also reflects shifts in the allocation of resources and development priorities, as the critical resources consumed for weaponization mean that they are also in short supply for clean energy production and just transition.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Przemyslaw Plucinski reports financial support was provided by Adam Mickiewicz University [ID-UB 047/01/POB5/0002]

[11] Polityka energetyczna Polski do 2040 r. – Ministerstwo Klimatu i Środowiska – Portal Gov.pl.

Table 2
Summary of policy implications in Norway, Germany, and Poland.

		Norway	Germany	Poland
Framework for economic development	Short-term	Benefit schemes supporting existing industries to improve energy efficiency Fixed electricity price agreements for companies The parliament decided to ban the use of fossil oils for heating for all households from 2020 onwards	Benefit schemes supporting industry natural gas price restrictions, as well as benefits for households dependent on gas, oil, and pallets	Just transition toward zero-carbon regime, with respect to various stakeholders
	Long term	Phasing out of oil production Transition from natural gas to green and blue hydrogen for export to Germany and the rest of Europe Developing national industries based on renewables to avoid offshoring	Restructuring the country's energy system Fostering development in post-coal regions Developing national industries based on renewables and hydrogen Subsidies for modernization of heating systems in existing buildings; currently discussed bans on fossil fuel-based heating systems in newly constructed buildings	Phase-out of coal dependency Fostering development in post-coal regions Developing national industries based on renewables
Framework for socio-economic equity	Short term	Anti-inflation policy Benefit schemes for vulnerable groups Short-term labor market policies (e.g., unemployment benefits)	Anti-inflation policy Benefit schemes for vulnerable groups Short-term labor market policies (e.g., unemployment benefits)	Anti-inflation policy Benefit schemes for vulnerable groups Policies for regional development in coal phase-out areas Short-term labor market policies (e.g., unemployment benefits) Environmental education
	Long term	Long-term labor market policies	Long-term labor market policies Educational system that provides expertise	Long-term labor market policies Educational system that provides expertise
Just access to rare earth minerals		See Fig. 3 Mining: Copper and nickel Recycling of batteries No uranium for nuclear power but access to thorium	See Fig. 3 No uranium for nuclear power	See Fig. 3 Additionally, access to uranium for planned nuclear plants

Source: own elaboration.

Data availability

In this perspective paper, we supported the analysis by publicly available secondary data.

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